

WHAT IS CLAIMED IS:

- 1 1. A vertical cavity surface emitting laser (VCSEL), comprising:
2 a vertical stack structure having a top surface and including
3 a top mirror,
4 a bottom mirror,
5 a cavity region disposed between the top mirror and the bottom
6 mirror and including an active light generation region,
7 at least one of the top mirror and the bottom mirror having at least
8 one layer defining a aperture region;
9 wherein the vertical stack structure defines at least one sidewall
10 area extending from the top surface to at least a depth
11 corresponding to the aperture region; and
12 a defect indicator system disposed in a screening region at the sidewall
13 area, the defect indicator system including an indicator layer with a chemically
14 alterable optical property, and a barrier layer overlying the indicator layer.
- 1 2. The VCSEL of claim 1, wherein the defect indicator system is
2 disposed over surfaces of the vertical stack structure defining at least one etched
3 hole.
- 1 3. The VCSEL of claim 1, wherein the indicator layer has a chemically
2 alterable optical reflectivity.
- 1 4. The VCSEL of claim 3, wherein the chemically altered optical
2 reflectivity of the indicator layer is detectable at a radiation wavelength within a
3 range of about 390 nm to about 770 nm.
- 1 5. The VCSEL of claim 1, wherein the indicator layer includes a metal.
- 1 6. The VCSEL of claim 5, wherein the indicator layer includes at least
2 one of the following: aluminum; an aluminum alloy; titanium; and a titanium
3 alloy.
- 1 7. The VCSEL of claim 1, wherein the indicator layer includes a base
2 layer impregnated with a dye.

1 8. The VCSEL of claim 1, wherein the indicator layer includes a
2 polymer.

1 9. The VCSEL of claim 1, wherein the overlying barrier layer is formed
2 of an electrically insulating material.

1 10. The VCSEL of claim 9, wherein the overlying barrier layer is formed
2 of an electrically insulating semiconductor material.

1 11. The VCSEL of claim 10, wherein the overlying barrier layer is
2 formed of at least one of a semiconductor oxide material and a semiconductor
3 nitride material.

1 12. The VCSEL of claim 1, wherein the defect indicator system further
2 includes a barrier layer underlying the indicator layer.

1 13. The VCSEL of claim 12, wherein the underlying barrier layer is
2 formed of an electrically insulating material.

1 14. The VCSEL of claim 13, wherein the underlying barrier layer
2 includes a nitride.

1 15. The VCSEL of claim 1, wherein:
2 the defect indicator system includes a peripheral edge intersecting the top
3 surface of the vertical stack structure at a moisture penetration interface; and
4 at the top surface of the vertical stack structure the sidewall area is
5 circumscribed by a respective peripheral edge having a substantial portion
6 separated from the moisture penetration interface by a distance of approximately
7 1 μm or greater.

1 16. A method of manufacturing a vertical cavity surface emitting laser
2 (VCSEL), comprising forming:
3 a vertical stack structure having a top surface and including
4 a top mirror,
5 a bottom mirror,

6 a cavity region disposed between the top mirror and the bottom
7 mirror and including an active light generation region,
8 at least one of the top mirror and the bottom mirror having at least
9 one layer defining an aperture region;
10 wherein the vertical stack structure defines at least one sidewall
11 area extending from the top surface to at least a depth
12 corresponding to the aperture region; and
13 a defect indicator system disposed in a screening region at the sidewall
14 area, the defect indicator system including an indicator layer with a chemically
15 alterable optical property, and a barrier layer overlying the indicator layer.

1 17. The method of claim 16, further comprising exposing at least the
2 screening region to a screening agent having at least one component chemically
3 reactive with the indicator layer to alter the optical property of the exposed
4 indicator layer.

1 18. The method of claim 17, further comprising optically inspecting the
2 exposed screening region for defects based on alteration of the optical property of
3 the exposed indicator layer.

1 19. The method of claim 17, wherein the indicator layer includes at
2 least one component oxidizable by at least one oxidizing component of the
3 screening agent.

1 20. The method of claim 17, wherein the overlying barrier layer is
2 formed of a material defect-free regions of which are substantially impermeable to
3 the screening agent.